

A NEW RF LABORATORY FOR DEVELOPING ACCELERATOR CAVITIES AT THE UNIVERSITY OF HUELVA

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Abstract

The University of Huelva is presently involved in R&D projects for developing RF accelerator cavities. Two types of cavities are presently under design, a prototype of room temperature RFQ injector and a quarter-wave resonator for high intensity heavy-ion linear accelerators. The laboratory is equipped with dedicated test-bench for RF measurements, which includes high-power RF generators, network analyzer, amplifiers and power meters. A clean room is also available having a dedicated space for high-precision mechanical metrology and cavity mounting, together with a vertical cryostat for superconducting cavity test.

INTRODUCTION

Heavy-ion accelerators are the cornerstones of nuclear physics research. As our knowledge of subatomic degrees of freedom has increased during the last decade, new physics phenomena have emerged that require the construction of high intensity heavy-ion beams, with heavy-ion beam intensities of several milliamps on target.

A number of facilities are presently in construction around the world (ESS-Sweden, FRIB-USA, SPIRAL2-France) with will be soon operating and recognized as leading international research infrastructures. The need of high intensity beams demands however an important technological effort in developing high field RF accelerating cavities.

The main interest of implementation of a Radio-Frequency RF Laboratory at University of Huelva is to test the performance of RF cavity prototypes, allowing for improving the electromagnetic and thermo-mechanical design, mainly focused on heavy ion accelerators.

RF LABORATORY

The RF laboratory is complementary to a cryostat system foreseen for testing superconducting cavities. Main equipment of the lab is listed below:

- Agilent CX N9000A spectrum analyzer.
- Agilent 53181A, Frequency counter
- Rhode and Swartz Network analyzer 9k-6GHz
- 3 kW power-amplifier from DB-Elettronica
- Analog RF signal generator MXG N5181AEP from Keysight Technologies.



Figure 1: Bead pull system and cold model of RFQ in aluminium.

The lab is also equipped with a remotely operated beam pull system for field measurements (Fig. 1). The clean room is close to the test cryostat where superconducting cavities can be tested at $T=4.5^{\circ}\text{K}$. The space dedicated to the clean room has been prepared for assembly and testing of both particle detector systems and RF cavity systems. Total surface is of 50 m^2 , divided in three main areas (Fig. 2):

- An over-pressurized area for entry of personnel and equipments of 20 m^2 (SAS).
- An ISO8 area of 30 m^2 containing a metrology system for quality control of mechanical elements.
- An ISO5 area of 4 m^2 has been prepared for special system assembly and manipulation.

The associated auxiliary equipment has been installed in a separate area of 18 m^2 close by the research complex.

First RF Tests

First activity of the lab has been dedicated to build and test a cold model (aluminium) of a RFQ cavity with design goal of 75.25 MHz , a representative working frequency of superconducting heavy-ion linacs. We have chosen an octagonal shaped cavity of 500 mm length (see Fig. 1), where four-vanes can be fixed using screws to the

cavity walls. A set 8 rectangular shapes are assembled to build the chamber wall, which is closed by using two octagonal end-caps. The full system has been calculated and optimized using COMSOL Multiphysics [1].

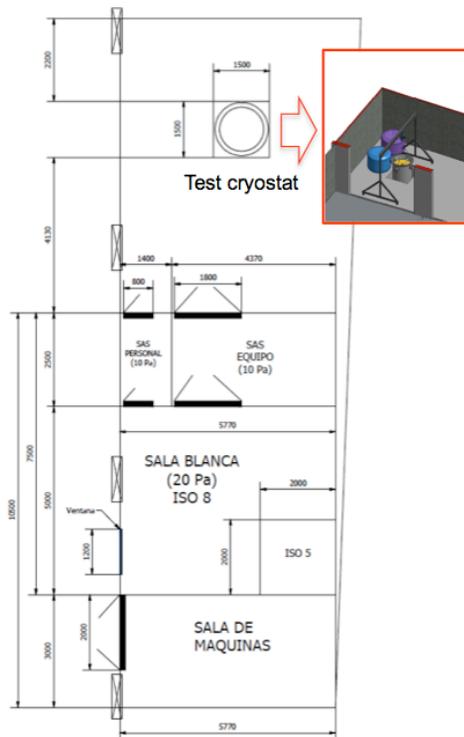


Figure 2: Sketch of the clean room build for RF cavity assembly and test.

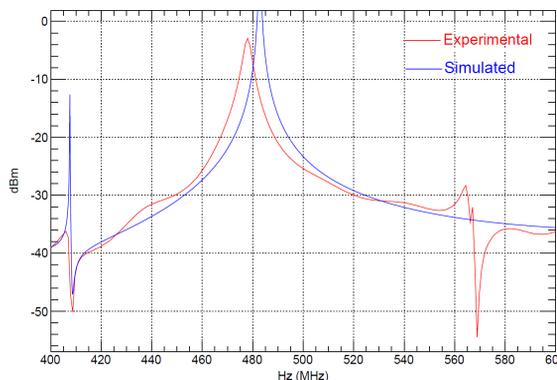


Figure 3: RFQ frequency test at the RF lab.

As a first step, we have tested the cavity without the vanes. Frequency range under study was between 100 MHz and 1 GHz. Resonant frequencies found are: 390.7, 406.0, 478.0, 564.5, 675.1, 685.0, 877.6 and 918.1 MHz, in good agreement with results of COMSOL calculations (Fig. 3).

SUMMARY AND CONCLUSIONS

A new RF laboratory for RF cavity testing is being installed at the University of Huelva. The laboratory has been equipped with a 50 m² clean room, a test cryostat and basic equipment for RF characterization and power measurement. First test of cavities have been carried out using a 75.25 MHz aluminium model of heavy ion RFQ.

ACKNOWLEDGMENT

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REFERENCES

- [1] Comsol website:
<http://www.comsol.com/products/multiphysics>